Extracorporeal Shock Wave Therapy for the Management of Burn Scars

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BACKGROUND Hypertrophic and contracture scars are common problems after burn injuries and cause functional and cosmetic deformities. A wide variety of treatments has been advocated for postburn pathologic scars regression. Unfortunately, the reported efficacy has been variable.

OBJECTIVES To investigate the use of extracorporeal shock wave therapy (ESWT), which mainly targets the fibroblasts in scar tissue, as an effective modality for scar treatment in burn patients.

MATERIALS AND METHODS An experimental study with ESWT was performed in 16 patients with postburn scars contractures, hypertrophic scars, or keloids twice a week for 6 weeks. Digital photographs were obtained and visual analogue scales were completed before and after treatment.

RESULTS Already after the first session, scars appeared more pliable, and color mismatch was less evident. At the end of the study period, all treated scars obtained a more acceptable appearance.

CONCLUSIONS Extracorporeal shock wave therapy is a feasible and cost-effective treatment in the management of postburn pathologic scars.

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Introduction

In burn patients, scar evolution may lead, according to its pathology, to the formation of scar contractures, hypertrophic scars, and keloids. Postburn pathologic scars involve functional and aesthetic limitations that have a dramatic influence on the patient's quality of life.

Physical therapy and, in many cases, pressure and exercise can aid in controlling contracture burn scars, but we wanted to investigate a new conservative method for the management of postburn scars.

Extracorporeal shock waves (ESWs), adapted from the technology used to break up kidney stones,[1] are used to good effect in the treatment of soft tissue injuries.[2] Although the underlying mechanisms are unclear, shock waves have been shown to increase blood supply to the treated area.[3] In addition, they manipulate inflammatory processes, stimulate fibroblasts to rebuild injured tissues,[4] promote a linear pattern of healing in tendons and ligaments,[5] decrease pain, increase the immune response to acute injuries,[6] and bolster the immune system to promote healing of chronic injuries.[7] Moreover, the potential use of ESWs on burn injuries has been described in a few experimental studies.[8–10] The research we conducted focused on the application of ESWs for the treatment of postburn scar contractures.

Materials and methods

From January to July 2010, six women and 10 men (n = 16, aged 19–74, mean 45.8) with

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functionally and cosmetically relevant postburn scar contractures or hypertrophic scars were treated with ESWs. Scars were located on the extremities in 69% of the patients, on the face or mentosternal region in 19%, and on the trunk in 12%. With regard to burn etiology, nine of 16 patients had a thermal burn, five were involved in explosions, and two reported a chemical burn. See Table 1 for the relevant demographic data.

Fifty-seven percent of all postburn scars required surgical debridement and grafting, and 20% of them needed more than one procedure. The patients were counseled about the possibility of treating the scars with shock waves to improve scar appearance and pliability.

On the day that patients gave consent to the procedure, a digital photograph of the scar was taken and the subjects were asked to quantify scar appearance on a visual analog scale (VAS; 0 = poor to 10 = excellent).[11] The final score was derived from the evaluation of factors such as scar thickness, pliability, pigmentation, and acceptability; observer comfort; and movement impairment.

Patients underwent sessions of extracorporeal shock wave therapy (ESWT) twice a week for 6 weeks. ESWT was administered on an outpatient basis, without anesthesia or antibiotics, to a limited area of the wound site, usually the most uncomfortable for the patient (Table 1). During the treatments no bleeding, petechiae, or hematoma occurred, but some patients had pain.

TABLE 1. Demographic Data of the Patients

Patient No.	*Sex/Age*	*Cause*	*Wound Site*	*Treated Area*	*TBSA, %*	*VAS Before*	*VAS After 12 Treatments*
1	M/27	Thermal burn (hot oil)	Left forearm	Proximal region	4.5	3	6
2	M/52	Chemical burn (sodium hydroxide)	Right hand	Palm	1	6	8
3	M/48	Thermal burn (flame)	Mento-sternal region	Neck	10	4	7
4	F/34	Thermal burn (steam)	Arms	Right arm	18	4	5
5	M/33	Explosion (gas grill)	Right hand and arm	Hand	10	2	6
6	F/41	Chemical burn (concentrated $AgNO_3$)	Left hand	Palm	1	5	7
7	F/74	Thermal burn (hot surface)	Elbows	Left elbow	3	2	4
8	M/46	Explosion (propane heater)	Mento-sternal region	Neck	10	1	3
9	M/55	Explosion (propane heater)	Abdomen	Right upper quadrant	18	2	3
10	F/67	Thermal burn (hot water)	Legs	Right leg	36	4	6
11	M/19	Thermal burn (flame)	Left hand	Palm	1	3	7
12	M/28	Explosion (car accident)	Chest	Left side	9	4	6
13	F/31	Thermal burn (hot water)	Both hands	Right hand	2	5	7
14	M/64	Thermal burn (hot surface)	Left forearm	Proximal region	4	4	6
15	F/72	Thermal burn (steam)	Left hand and forearm	Hand	5	2	5
16	M/43	Explosion (gas grill)	Face	Chin	4.5	3	7

TBSA, total body surface area; VAS, visual analogue scale.

Figure 1. A 27-year-old patient with a postburn scar contracture of the left arm. Extracorporeal shock wave therapy sessions were administered to a limited area of the wound site (the proximal region) because this was described as the most uncomfortable for the patient.

The instrument used was an Evotron (High Medical Technologies, Lengwil, Switzerland). The current study protocol consisted of 100 impulses at 0.037 mJ/mm^2 /cm$^{-2.12}$ The focal spot size of the hand-held probes (Trode) was 10–15 mm in diameter and the total energy applied for each impulse was 3.5 mJ, with a frequency of 4 Hz or 240 impulses/minute. The average time for each session was 5–10 minutes (Figure 1).

After completion of ESWT, patients were reviewed every 2 weeks for 2 months and completed a new VAS. Progress of the postburn scars was documented using digital photography and assessed by comparing before-and-after photographs and VAS scores.

Results

All patients enrolled in the study completed the 12 sessions of ESWT. The treatment was well tolerated, without any adverse side effects. No bleeding, petechiae, hematoma, or seroma was observed, although five of 16 patients reported some pain during treatment. Most were initially startled by the sound emitted by the machine as it generated the shock waves. Therefore, it is recommended that the patient be briefed on the possible emission of sound and light.

Figure 2. A 48-year-old patient with a postburn scar contracture extending from the upper thorax to the neck. The thermal burn injury was caused by a flame that developed as he was doing some housework in spring 2009.

After the first session, scars appeared more pliable, and color mismatch was less evident. At the end of the study period, patients reported that scars were less painful, less stiff, and thinner. Scar color became more similar to that of the surrounding skin and the texture less firm; the overall appearance was improved, and the patients considered their experience to be more acceptable. Movement also became less impaired (Figures 2 and 3).

According to the VAS, scar appearance improved 3 points for three patients (18.75%), 2 points for eight patients (50%), 1 point for two patients (12.5%), and 0 points for three patients (18.75%).

Discussion

Pathologic scarring is a common problem after burn injuries. Normal elastic connective tissues are replaced with inelastic fibrous tissue, making the tissues resistant to stretching and preventing normal movement of the affected area, as well as causing considerable disfigurement.

Figure 3. The patient underwent sessions of extracorporeal shock wave therapy twice a week for 6 weeks in the neck region. From the second session, the patient could already see improvement in the scar region, becoming softer and more movable. After 6 weeks, the patient noticed softening of the skin texture and an improvement in neck movement, particularly lateral flexion and rotation.

A variety of techniques is available in burn reconstructive surgery to improve the outcomes of postburn scars.[13] Current treatment modalities include conservative and surgical measures. The range of treatments for postburn reconstructive surgery typically comprises free skin transplants (split or full thickness), cultured keratinocyte grafting, or the use of tissue expanders with various flap procedures. With reference to conservative treatments, deep tissue massage helps to break down the fibrous mesh that is formed in scar tissue, encouraging remodeling of the tissue. A physiotherapist can perform the massage, or a mechanical roller can be used, but these treatments may not always be satisfactory.

Scar revision and management remains a major challenge in the field of reconstructive surgery, and numerous investigations are focusing on identifying alternative approaches. This study investigated the use of ESWs as a noninvasive modality for scar treatment in burn patients. Our research concerning the application of ESWT to chronic ulcers led to significant results, encouraging us to extend the investigation to other soft tissue disorders.

Shock waves are acoustic waves. The high-level energy that shock waves produce terminates in a burst of energy similar to a mini-explosion. This energy was used as ESWT for the first time in the 1980s, when it was successfully introduced to urology and gastroenterology as lithotripsy.[1,14] In the early 1990s, ESWT began to be used in orthopedics.[15] More recently, it has been found that ESWT could be beneficial in healing wounds.

The action of ESWT is to mechanically disrupt the tissue by cavitation.[16] The repair of the tissue provides the theoretical basis for the neovascularization process and subsequent pain relief after ESWT.[17]

Although the mechanism of ESWT disintegration of renal calculi is well understood,[18] the current mechanism of ESWs in the treatment of musculoskeletal disorders has not been completely covered.

The delivery of shock waves to scar tissue is thought to cause microscopic injury that breaks down collagen fibers, which enables remodeling of scars. In our study, ESWT was administered to 16 postburn patients to investigate whether it could be a new conservative treatment method in the management of postburn scars. The intensity, duration, and frequency of the treatments were chosen thanks to a previous study concerning chronic ulcers in lower extremities.[12] It was thought that the parameters used to treat chronic wounds would be sufficient to treat burn scars because the common etiology is the pathologic healing process. We administered ESWT sessions twice per week, because this was the same frequency that the team used with chronic ulcers. For the time being, there is no reason to increase or decrease the frequency of the treatment, but further research can provide sufficient data to change the parameters. The pro-

cedure was well tolerated, and patient adherence was good. Significant improvement in scar elasticity, color, and overall appearance was noticed from the first sessions.

Conclusion

Extracorporeal shock wave therapy is an effective and conservative treatment for patients with aesthetic and functional sequela from burn scars. It is a feasible, cost-effective, well-tolerated treatment that can be used in the management of postburn pathologic scars after the patients are briefed on the practical aspects of the treatment procedure.

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